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AUTHOR Cole, Herbert, Jr.
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ABSTRACT

This agriculture extension service publication from Pennsylvania State University consists of conversion tables and formulas for determining concentration and rate of application of pesticides. Contents include: (1) Area and volume conversions; (2) Important conversion formulae; (3) Conversions for rates of application; (4) Quantities of pesticide necessary to achieve the same concentrations in various quantities of water; (5) Spray concentration conversions; (6) Tractor speed conversions; (7) Acres sprayed per tankful; and (8) Calibration of nozzle flow rates. Metric conversion factors are provided. (MR)

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CALCULATION METHODS AND CONVERSIONS FOR PESTICIDE APPLICATION

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USEFUL CALCULATION METHODS TO DETERMINE VARIOUS APPLICATION CRITERIA

1. To determine the amount of active ingredient needed to mix in the spray tank:

$$\text{Number of gallons or pounds} = \frac{\text{number of acres to be sprayed} \times \text{pounds active ingredient required per acre}}{\text{pounds active ingredient per gallon or per pound}}$$

2. To determine the amount of pesticide needed to mix a spray containing a certain percentage of the active ingredient:

$$\text{Number of gallons or pounds} = \frac{\text{gallons of spray desired} \times \text{\% active ingredient wanted} \times 8.345^{*}}{\text{pounds active ingredient per gallon or per pound} \times 100}$$

3. To determine the percent active ingredient in a spray mixture:

$$\text{Percent} = \text{pounds or gallons of concentrate used (not just active ingredient)} \times \frac{\text{\% active ingredient in the concentrate}}{\text{gallons of spray} \times 8.345}$$

4. To determine the amount of pesticide needed to mix a dust with a given percent active ingredient:

$$\text{Pounds material} = \frac{\text{\% active ingredient wanted} \times \text{pounds mixed dust wanted}}{\text{\% active ingredient in pesticide used}}$$

5. To determine the size of pump needed to apply a given number of gallons per acre:

$$\text{Pump capacity} = \frac{\text{gallons per acre desired} \times \text{boom width (feet)} \times \text{mph}}{495}$$

6. To determine the nozzle capacity in gallons per minute at a given rate per acre and miles per hour:

$$\text{Nozzle capacity} = \frac{\text{gallons per acre} \times \text{nozzle spacing (inches)} \times \text{mph}}{5940}$$

7. To determine the acres per hours sprayed:

$$\text{Acres per hour} = \frac{\text{swath width (inches)} \times \text{mph}}{100}$$

8. To determine the rate of speed in miles per hours:
   First measure off a distance of 300 to 500 feet; then measure in seconds the time it takes the tractor to go the marked-off distance.

$$\text{mph} = \frac{.682 \times \text{distance}}{\text{seconds to travel distance}}$$

*8.345 is the weight in pounds of one gallon of water.

9. To determine the nozzle flow rate:
   First note the time in seconds necessary to fill a pint jar from a nozzle.
   Gallons per minute per nozzle = $\frac{7.5}{\text{seconds to fill jar}}$

10. To determine the gallons per minute per boom:
    Calculate the gallons per minute per nozzle and multiply by the number of nozzles.

11. To determine the gallons per acre delivered:
    Gallons per acre = $\frac{5940 \times \text{gallons per minute per nozzle}}{\text{nozzle spacing (inches)} \times \text{mph}}$

12. To determine the acreage sprayed per hour:
    Acre sprayed per hour = $\frac{\text{boom width (feet)} \times \text{mph}}{12}$
    (This allows 30% of the time for filling, turning, etc.)

13. Sprayer Tank Capacity
    For cylindrical tanks:
    Number of gallons = length in inches x diameter squared x .0034
    For elliptical tanks:
    Number of gallons = length in inches x short diameter x long diameter x .0034
    For rectangular tanks:
    Number of gallons = length x width x depth x .004329

14. To determine the acres in a given area:
    Number of acres = length in feet x width in feet x .000023

15. To calibrate a knapsack sprayer:
    Spray a measured square rod area for one minute and catch the spray from the nozzle or nozzles.
    Gallons per acre = 20 x pints caught in one minute

AREA AND VOLUME CONVERSIONS

LINEAR MEASURE

1 foot = 12 inches
1 yard = 3 feet
1 rod = 5.5 yards = 16.5 feet
1 mile = 160 rods = 1760 yards = 5280 feet

SQUARE MEASURE

1 square foot = 144 square inches
1 square yard = 9 square feet
1 square rod = 272.25 square feet = 30.25 square yard
1 acre = 43,560 square feet = 4840 square yards = 160 square rods
1 square mile = 640 acres
1 acre = 209 square feet

CUBIC MEASURE

1 cubic foot = 1728 cubic inches = 29.922 quarts = 7.48 gallons
1 cubic yard = 27 cubic feet
1 cubic foot of water = 62.5 pounds

LIQUID CAPACITY MEASURE

1 tablespoon = 3 teaspoons
1 fluid ounce = 2 tablespoons
1 cup = 8 fluid ounces
1 pint = 2 cups = 16 fluid ounces
1 quart = 2 pints = 32 fluid ounces
1 gallon = 4 quarts = 8 pints = 128 fluid ounces

WEIGHT MEASURE

1 pound = 16 ounces
1 hundredweight = 100 pounds
1 ton = 2000 pounds = 20 hundredweight

METRIC MEASURE

1 gram = .035 ounce
1 kilogram = 2.2 lb
1 quintal = 100 kg = 221 lb
1 metric ton = 1000 kg = 2,205 lb
1 hectare = 2.5 acres
1 meter = 39.4 inches
1 kilometer = .6 mile

TEMPERATURE CONVERSIONS

°F	°C	°F	°C
32.0	0	78.8	26
35.6	2	82.4	28
39.2	4	86.0	30
42.8	6	89.6	32
46.4	8	93.2	34
50.0	10	96.8	36
53.6	12	100.4	38
57.2	14	104.0	40
60.8	16	122.0	50
64.4	18	140.0	60
68.0	20	158.0	70
71.6	22	176.0	80
75.2	24	194.0	90
		212.0	100

IMPORTANT CONVERSION FORMULAE

volume of a sphere = diameter ^{3} x .5236
diameter = circumference x .31831
area of a circle = diameter ^{2} x .7854
area of an ellipse = wide diameter x narrow diameter x .7854
volume of a cone = area of base x $\frac{\text{height}}{3}$

pressure in pounds per square inch = height in feet x .434
parts per million = percentage x 10,000
percentage = $\frac{\text{parts per million}}{10{,}000}$

The formula for conversion from Centigrade to Fahrenheit is:
$^\circ F = (\frac{^\circ C \times 9}{5}) + 32$ or $^\circ F = (^\circ C \times 1.8) + 32$

The formula for conversion from Fahrenheit to Centigrade is:
$^\circ C = (^\circ F - 32) \times \frac{5}{9}$ or $^\circ C = (^\circ F - 32) \times 0.5556$

CONVERSION FACTORS

To Convert from	To	Multiply by
cubic feet	gallons	7.48
cubic feet	liters	28.3
gallons	milliliters	3785
grams	pounds	.0022
grams/liter	parts/million	1000
grams/liter	pounds/gallon	.00834
liters	cubic feet	.0353
milligrams/liter	parts/million	1.0
milliliters	gallons	.0026
ounces	grams	28.35
parts/million	grams/liter	.001
parts/million	pounds/million gallons	8.34
pounds	grams	453.59
pounds/gallon	grams/liter	111.83

CONVERSIONS FOR RATES OF APPLICATION

1 ounce per square foot	= 2722.5 pounds per acre
1 ounce per square yard	= 302.5 pounds per acre
1 ounce per 100 square feet	= 27.2 pounds per acre
1 pound per 100 square feet	= 435.6 pounds per acre
1 pound per 1000 square feet	= 43.6 pounds per acre
1 gallon per acre	= 1/3 ounce per 1000 square feet
5 gallons per acre	= 1 pint per 1000 square feet
100 gallons per acre	= 2.5 gallons per 1000 square feet
	= 1 quart per 100 square feet
100 pounds per acre	= 2.5 pounds per 1000 square feet

APPLICATION RATES OF ACTIVE INGREDIENT PER ACRE FOR VARIOUS CONCENTRATIONS OF EMULSIFIABLES, WETTABLES, AND DUSTS

Pounds of active chemical recommended per acre:									
1/8	1/4	1/2	3/4	1	1 1/2	2	2 1/2	3	5
Amount of formulation needed to obtain the above amounts of active chemical for:									
10%-12% Emulsion Concentrate (contains 1 pound chemical per gallon)									
1 pt	1 qt	2 qt	3 qt	1 gal	1 1/2 gal	2 gal	2 1/2 gal	3 gal	5 gal
15%-20% Emulsion Concentrate (contains 1 1/4 pounds chemical per gallon)									
1/3 qt	2/3 qt	1 1/3 qt	2 qt	2 2/3 qt	1 gal	1 1/3 gal	1 2/3 gal	2 gal	3 2/5 gal
25% Emulsion Concentrate (contains 2 pounds chemical per gallon)									
1/2 pt	1 pt	1 qt	3 pt	2 qt	3 qt	1 gal	5 qt	1 1/2 gal	2 1/2 gal
40%-50% Emulsion Concentrate (contains 4 pounds chemical per gallon)									
1/4 pt	1/2 pt	1 pt	1 1/2 pt	1 qt	3 pt	2 qt	5 pt	3 qt	5 qt
60%-65% Emulsion Concentrate (contains 6 pounds chemical per gallon)									
1/6 pt	1/3 pt	2/3 pt	1 pt	1 1/3 pt	1 qt	2 2/3 pt	3 1/3 pt	2 qt	3 1/3 qt
70%-75% Emulsion Concentrate (contains 8 pounds chemical per gallon)									
1/8 pt	1/4 pt	1/2 pt	3/4 pt	1 pt	1 1/2 pt	1 qt	2 1/2 pt	3 pt	2 1/2 qt
15% Wettable Powder									
3/4 lb	1 1/2 lb	3 1/3 lb	5 lb	6 2/3 lb	10 lb	13 1/2 lb	16 2/3 lb	20 lb	33 1/3 lb
25% Wettable Powder									
1/2 lb	1 lb	2 lb	3 lb	4 lb	6 lb	8 lb	10 lb	12 lb	20 lb
40% Wettable Powder									
5 oz	10 oz	1 1/4 lb	1 7/8 lb	2 1/2 lb	3 3/4 lb	5 lb	6 1/4 lb	7 1/2 lb	12 1/2 lb
50% Wettable Powder									
1/4 lb	1/2 lb	1 lb	1 1/2 lb	2 lb	3 lb	4 lb	5 lb	6 lb	10 lb
75% Wettable Powder									
1/6 lb	1/3 lb	2/3 lb	1 lb	1 1/3 lb	2 lb	2 2/3 lb	3 1/3 lb	4 lb	6 2/3 lb
80% Wettable Powder									
2 1/2 oz	5 oz	5/8 lb	15/16 lb	1 1/4 lb	1 7/8 lb	2 1/2 lb	3 1/8 lb	3 3/4 lb	6 1/4 lb
1% Dust									
12 1/2 lb	25 lb	50 lb	75 lb	100 lb	150 lb	200 lb	250 lb	300 lb	500 lb
5% Dust									
2 1/2 lb	5 lb	10 lb	15 lb	20 lb	30 lb	40 lb	50 lb	60 lb	100 lb
10% Dust									
1 1/4 lb	2 1/2 lb	5 lb	7 1/2 lb	10 lb	15 lb	20 lb	25 lb	30 lb	50 lb

QUANTITIES OF PESTICIDE NECESSARY TO ACHIEVE THE SAME CONCENTRATION IN VARIOUS QUANTITIES OF WATER

WATER	PESTICIDE (Powder)				
100 gal	1 lb	2 lb	3 lb	4 lb	5 lb
50 gal	.5 lb	1 lb	1.5 lb	2 lb	2.5 lb
12 1/2 gal	4 oz	8 oz	12 oz	1 lb	1.25 lb
6 1/4 gal	2 oz	4 oz	6 oz	8 oz	10 oz
3 1/8 gal	1 oz	2 oz	3 oz	4 oz	5 oz
1 gal	4.5 g	9.1 g	13.6 g	18.1 g	22.7 g
1 liter	1.2 g	2.4 g	3.6 g	4.8 g	6.0 g
1 qt	1.1 g	2.3 g	3.4 g	4.5 g	5.7 g

WATER	PESTICIDE (Liquid)				
100 gal	.5 pt	1 pt	1 qt	2 qt	1 gal
50 gal	.25 pt	.5 pt	1 pt	1 qt	2 qt
25 gal	2 oz	4 oz	8 oz	1 pt	1 qt
12 1/2 gal	1 oz	2 oz	4 oz	8 oz	1 pt
6 1/4 gal	.5 oz	1 oz	2 oz	4 oz	8 oz
3 1/8 gal	.25 oz	.5 oz	1 oz	2 oz	4 oz
1 gal	.75 oz	1.5 oz	3 oz	6.25 oz	12.5 oz
1 liter	0.625 ml	1.25 ml	2.5 ml	5.0 ml	10.0 ml
1 qt	.2 oz	4 oz	8 oz	1.5 oz	3.2 oz

* fluid oz

CONCENTRATIONS OF CHEMICALS IN SOIL

Amount of Chemical Required to Give Indicated Concentration in Soil*

Parts per Million Concentration in Soil	1 Square Foot To Soil Depth Of:			1000 Square Feet To Soil Depth Of:			1 Acre (43,560 sq ft) Soil Depth Of:		
	1 inch	4 inches	12 inches	1 inch	4 inches	12 inches	1 inch	4 inches	12 inches
1	-	.01 g	.04 g	.11 oz	.43 oz	1.3 oz	0.3 lb	1.2 lb	3.5
10	-	0.1 g	0.4 g	1.1 oz	4.3 oz	13 oz	3 lb	12 lb	35 lb
50	0.2 g	0.7 g	2 g	5.4 oz	1.3 lb	4 lb	14 lb	58 lb	175 lb
100	0.38 g	1.3 g	4 g	10.8 oz	2.7 lb	8 lb	29 lb	117 lb	350 lb
150	0.5 g	2.0 g	6 g	1.0 lb	4 lb	12 lb	44 lb	175 lb	525 lb
200	0.8 g	2.6 g	8 g	1.3 lb	5.3 lb	16 lb	58 lb	233 lb	700 lb
500	1.7 g	6.7 g	20 g	3.3 lb	13.3 lb	40 lb	146 lb	583 lb	1750 lb
1000	3.4 g	13.4 g	40 g	6.7 lb	26.7 lb	80 lb	292 lb	1167 lb	3500 lb

* Assumes soil specific gravity of 1.3, equivalent to 81 pounds of dry soil per cubic foot. Modify amounts of chemical proportionately for higher or lower specific soil gravity.

SPRAY CONCENTRATION CONVERSIONS

Ounces Per 100 Gallons	Parts per Million	Percent Solution	Grams per 100 liters
2/3	50	.005	5
1	75	.0075	7.5
1 1/3	100	.01	10
2	150	.015	15
2 2/3	200	.02	20
3 1/3	250	.025	25
4	300	.03	30
5 1/3	400	.04	40
6 2/3	500	.05	50
8	600	.06	60
9 1/3	700	.07	70
10 2/3	800	.08	80
12	900	.09	90
13 1/3	1000	0.10	100
16	1200	0.12	120
20	1500	0.15	150
24	1800	0.18	180

PARTS PER MILLION RELATIONSHIPS

1 gram in 100 milliliters	=	10,000 ppm	=	1.0%
1 gram in 1 liter	=	1,000 ppm	=	0.1%
1 gram in 10 liters	=	100 ppm	=	0.01%
1 gram in 100 liters	=	10 ppm	=	0.001%
1 gram in 1000 liters	=	1 ppm	=	0.0001%
1 gram in 10,000 liters	=	0.1 ppm		

100 parts per million = 1.33 ounces per 100 gallons
OR
0.1 grams per liter
1 gram per 10 liters
10 grams per 100 liters
100 grams per 1000 liters

METRIC EQUIVALENTS

100 liters = 105.8 quarts = 26.45 gallons
100 gallons = 378.5 liters
1 ounce = 28.35 grams
1 gram = 0.035 ounces
10 grams = 0.35 ounces
100 grams = 3.35 ounces

CONVERSION TABLE FOR SMALL-AREA SPRAYING

Rate Per Acre	Rate Per 1,000 Square Feet	Rate Per 100 Square Feet	
1 lb	0.35 oz	0.25 tsp	Dry Materials
2	0.7	0.50 tsp	
3	1.1	0.75 tsp	
4	1.4	1.00 tsp	
5	1.8	1.25 tsp	
6	2.1	1.50 tsp	
8	2.8	1.75 tsp	
10	3.7	2.00 tsp	
20	7.3	0.73 oz	
40	14.0	1.4 oz	
50	18.0	1.8 oz	
100	37.0	3.7 oz	
200	73.0	7.3 oz	
300	110.0	11.0 oz	
400	147.0	14.7 oz	
500	184.0	18.4 oz	
1 pt	0.36 fl oz	0.25 tsp	Liquid Materials
1 qt	0.72 fl oz	0.50 tsp	
1 gal	2.9 fl oz	2.00 tsp	
2 gal	5.9 fl oz	4.00 tsp	
3 gal	8.8 fl oz	2.00 Tbsp	
5 gal	14.7 fl oz	3.00 Tbsp	
10 gal	29.4 fl oz	6.00 Tbsp	
15 gal	2.8 pt	9.00 Tbsp	
20 gal	3.7 pt	12.00 Tbsp	
25 gal	2.3 qt	15.00 Tbsp	
50 gal	4.6 qt	1.84 cups	
75 gal	6.9 qt	2.76 cups	
100 gal	9.19 qt	3.67 cups	
200 gal	18.37 qt	7.35 cups	

Dry: 1 lb/100 gal = 1 oz/6 1/4 gal = 1/2 oz/3 gal = 4.5 gm/gal
Liquid: 1 pt/100 gal = 1 fl oz/6 1/4 gal = 1/2 fl oz/3 gal = 1 tsp/gal
1 qt/100 gal = 10 tsp/5 gal = 2 Tbsp/3 gal = 2 tsp/gal
1 gal/100 gal = 3/4 cup + 4 tsp/5 gal = 1/2 cup/3 gal = 8 tsp/gal

QUANTITIES OF PESTICIDE IN LIQUID FORMULATION FOR EQUIVALENCE BETWEEN 100 GALLONS AND 1 GALLON

Pounds of Active Chemical per Gallon of Concentration	Teaspoons per Gallon To Equal 1 Pound per 100 Gallons Of Dilute Spray
1	8
2	4
3	3
4	2
6	1 1/2
8	1

TRACTOR SPEED CONVERSIONS

Miles per Hour	Feet per Minute	Time required in seconds to travel 100 feet	200 feet	300 feet
1	88	68	137	205
1.5	132	45	91	136
2	176	34	68	102
2.5	220	27	54	81
3	264	23	46	68
4	352	17	34	51
5	440	13.6	27	41
6	528	11.3	23	34
7	618	9.7	20	29
8	704	8.5	17	27

ACRES SPRAYED PER TANKFUL

Gallons per Acre	Tank Capacity 30	50	55	60	75	100	110	150	200	500
5	6.0	10.0	11.0	12.0	15.0	20.0	22.0	30.0	40.0	100.0
6	5.0	8.3	9.2	10.0	12.5	16.7	18.3	25.0	33.3	83.3
7	4.3	7.1	7.9	8.6	10.7	14.3	15.7	21.4	28.6	71.4
8	3.8	6.3	6.9	7.5	0.4	12.5	13.7	18.8	25.0	62.5
9	3.3	5.6	6.1	6.7	8.3	11.1	12.2	16.7	22.2	55.6
10	3.0	5.0	5.5	6.0	7.5	10.0	11.0	15.0	20.0	50.0
15	2.0	3.3	3.7	4.0	5.0	6.7	7.3	10.0	13.3	33.3
20	1.5	2.5	2.8	3.0	3.8	5.0	5.5	7.5	10.0	25.0

CONVERTING WIDTH OF AREA COVERED TO ACRES TRAVELED PER MILE

Width of Strip (feet)	Acres per Mile
6	.72
10	1.21
12	1.45
16	1.93
18	2.18
20	2.42
25	3.02
30	3.63
50	6.04
75	9.06
100	12.1
150	18.14
200	24.2
300	36.3

TRACTOR SPEED AND SPRAY RATES

$$\text{Tractor Speed} = \frac{\text{gallons per minute} \times 495}{\text{gallons per acre} \times \text{width of spray}}$$

$$\text{Gallons Per Acre} = \frac{\text{gallons per minute} \times 495}{\text{miles per hour} \times \text{width of spray}}$$

$$\text{Tractor Speed} = \frac{0.682 \times \text{distance}}{\text{seconds}}$$

$$\text{Gallons Per Minute} = \frac{\text{gallons per acre} \times \text{miles per hour} \times \text{nozzle spraying in inches}}{5{,}940}$$

CALIBRATION OF NOZZLE FLOW RATES

Gallons per Minute	Seconds for 1 pint	Gallons per Minute	Seconds for 1 quart
.05	150	.175	86
.06	125	.20	75
.07	107	.225	67
.08	94	.25	60
.09	84	.30	50
.10	75	.325	46
.11	68	.35	43
.12	62	.40	38
.13	58	.425	35
.14	53	.45	33
.15	50	.50	30

Compiled by Herbert Cole, Jr., Professor, Plant Pathology

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